MBD Associates

Presents

Adaptive Cruise Control

Adaptive Cruise Control

Welcome to the Adaptive Cruise Control program. This training program is designed to provide basic information about adaptive cruise control systems available on some vehicles. At the end of this training program, an online Post-Test is administered. Once you press "Submit" at the end of the Post-Test, the results will be displayed on screen. Upon passing the Post-Test, you will receive 0.25 Gold Class points.

Learning Objectives

The learning objectives for this program include:

- Identifying different adaptive cruise control systems.
- Identifying parts of adaptive cruise control systems.
- Identifying damage to adaptive cruise control systems.
- Diagnosing adaptive cruise control system problems.
- Replacing damaged adaptive cruise control system parts.

Adaptive Cruise Control

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Adaptive Cruise Control

Program Description

Summary

This training program provides basic details about adaptive cruise control (ACC) systems. Information will be presented about how an ACC system operates, availability, determining when a system is not working properly, and replacing parts.

Acronyms

The following acronyms are used in this program:

ABS	Anti-lock Brake System
ACC	Adaptive Cruise Control
DIC	Driver Information Center
DSCC	Distance Sensing Cruise Control (GM)
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
ECM	Engine Control Module (GM, Audi)
FLS	Forward Looking Sensor (GM)
HUD	Head-Up Display

An ACC system is designed to assist the driver when following a vehicle traveling in the same lane and direction.

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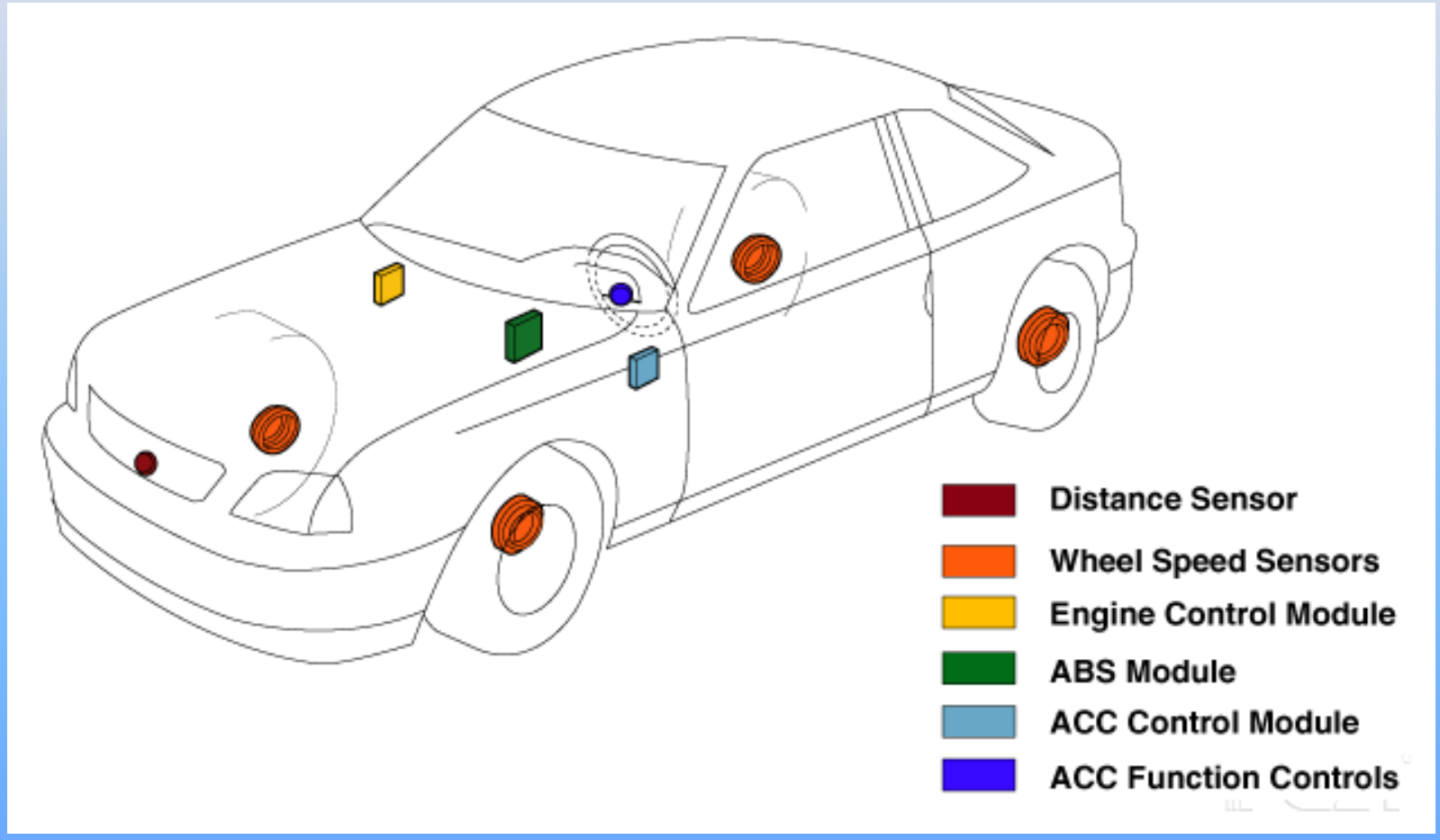
Parts related to a typical ACC system are highlighted and color-coded in the illustration below.



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System Description

Conventional Cruise Control Operation

A typical conventional cruise control system controls the vehicle speed by adjusting throttle position to maintain a speed set by the driver. A control unit compares the actual vehicle speed and the desired set speed. If there is a difference between these two values, a signal is sent to a throttle position actuator to adjust the throttle position to bring the vehicle to the set speed. Depending on vehicle make and model, throttle position is achieved using vacuum-powered or electronically controlled actuators.

Cruise control systems may also be known as speed control systems.

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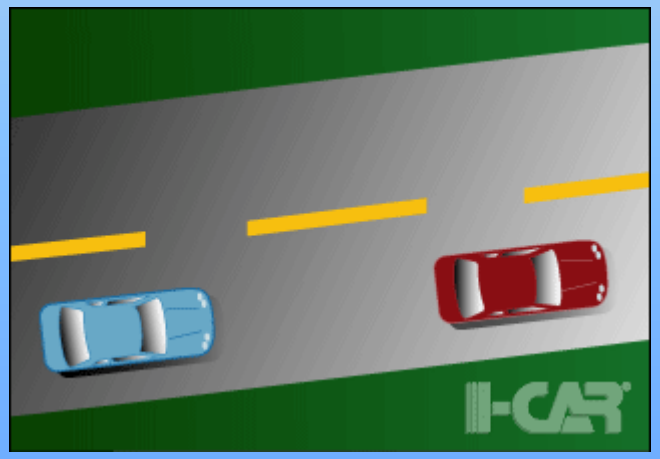
ACC Overview

ACC is an extension of conventional cruise control systems. An ACC system is a driver convenience feature designed to maintain a set following distance from the vehicle ahead. ACC is not a collision warning or avoidance system. An ACC system is designed to assist the driver and is not a fully independent driving system. As with conventional cruise control systems, manual inputs from the driver, both to the accelerator and brake, take priority over the ACC system.

Cruise control systems may also be known as speed control systems.



An ACC system uses a distance sensor that projects a beam forward to detect a vehicle ahead.

Adaptive Cruise Control

ACC systems allow for a set following distance or time interval between the ACC vehicle and the forward vehicle, as well as a set speed. Driver convenience is enhanced since fewer accelerating and braking operations are necessary.

The set distance (timed in seconds) is the desired distance between the ACC vehicle and the forward vehicle. When a forward vehicle is detected, controlling acceleration and braking operations without driver intervention maintains the set distance between vehicles.

The set speed is the desired maximum speed to be regulated by the ACC system on an open road. If no forward vehicle is detected, the set speed is regulated.

Shown is a radar sensor on a 2006 Jaguar XK.

Adaptive Cruise Control

Availability

Adaptive cruise control is the common term used for an enhanced cruise control system. Depending on the vehicle maker, ACC systems may also be called Active Cruise Control (BMW), Distronic (Mercedes-Benz), Dynamic Cruise Control (Lexus, Toyota), or Intelligent Cruise Control (Infiniti). Vehicle makers offering ACC systems include, but may not be limited to:

- Acura
- Audi
- BMW
- General Motors
- Infiniti
- Jaguar
- Lexus
- Mercedes-Benz
- Toyota
- Volkswagen
- Volvo

ACC systems are available on some vehicle models, such as the 2006 Jaguar XK (top), and the 2006 Cadillac DTS (bottom).

Adaptive Cruise Control

System Operation

ACC Engaged

An ACC system uses a distance sensor (either a radar or laser sensor depending on the vehicle maker) attached to the front of the vehicle to detect the presence of a vehicle ahead and the clearance between the ACC vehicle and the forward vehicle. Some sensor locations include under or behind the front bumper or behind the grille.

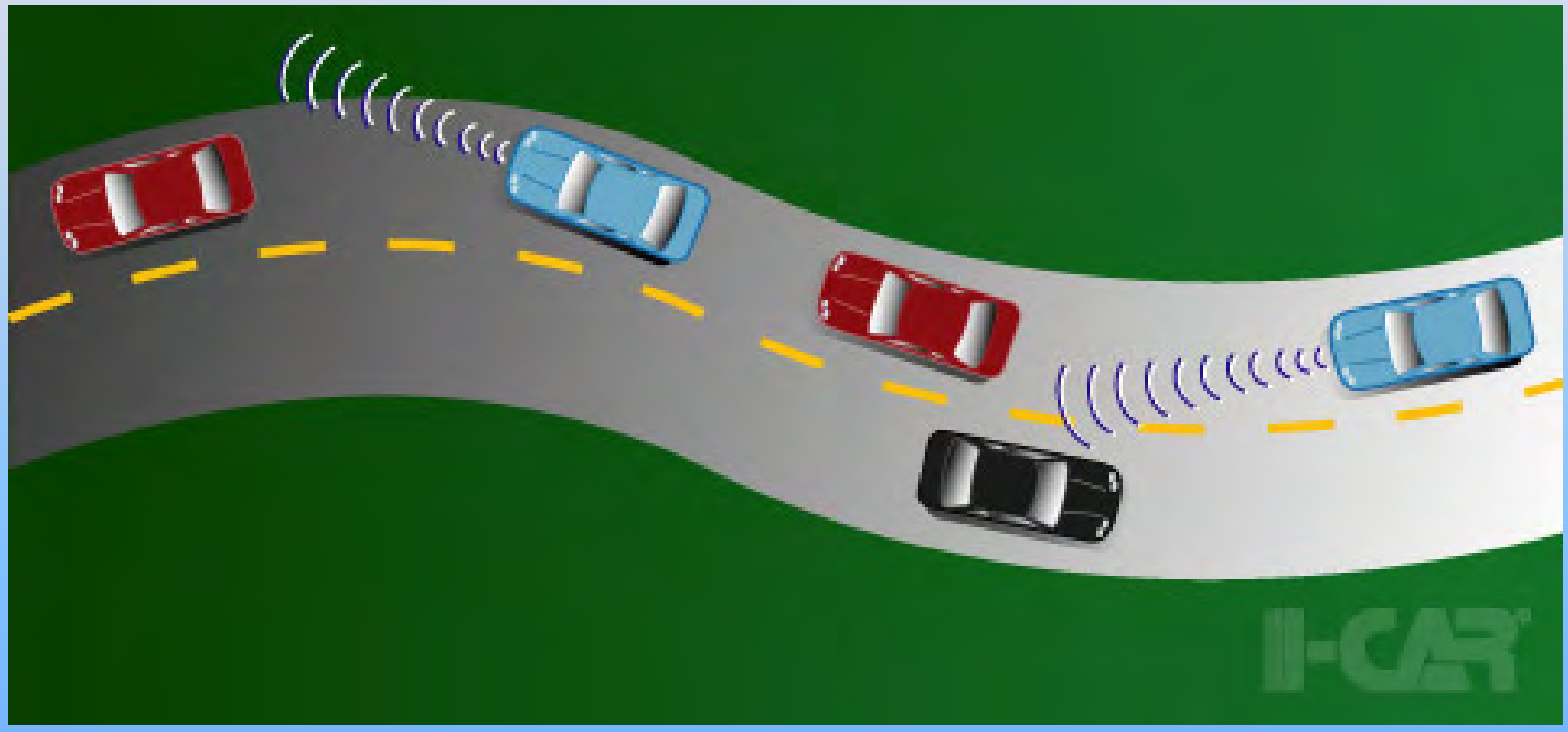
This laser-based distance sensor on a 2006 Infiniti FX35 is located below the front bumper.

Adaptive Cruise Control

System Operation

Vehicle Example

On a 2006 Lexus the maximum sensor detection range is approximately 120 m (400') ahead.
On a 2004 Audi A8 the maximum sensor detection range is approximately 130 m (425') ahead.

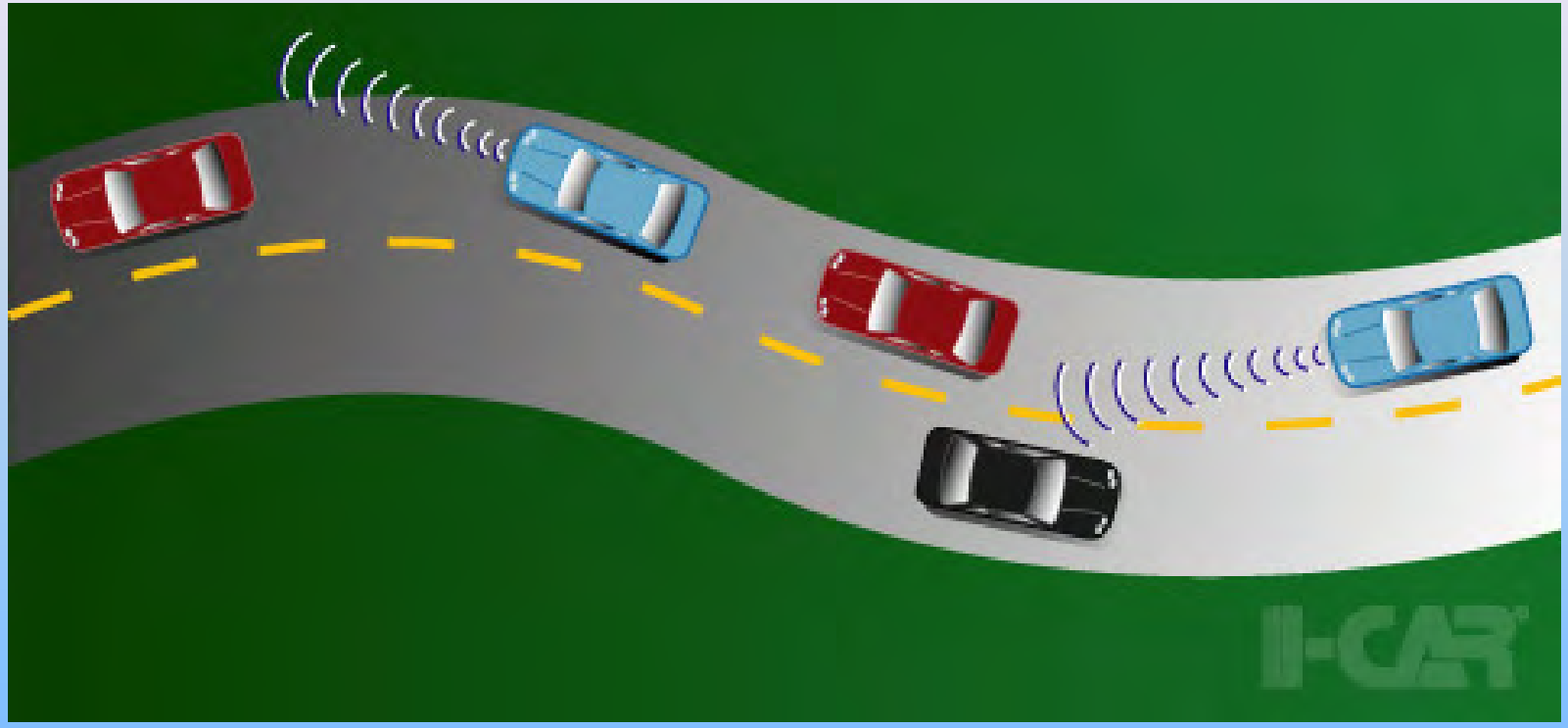


Traveling through a curve might have an effect on ACC operation.

Depending on the vehicle maker, the sensor may be a stand-alone unit, as in the Mercedes-Benz system, or it may be included with the system control module, as in the BMW and Cadillac systems. The control module is also integrated with other vehicle systems such as anti-lock brakes (ABS), traction and stability control systems, the engine control module, and body and transmission control modules.

Adaptive Cruise Control

System Operation

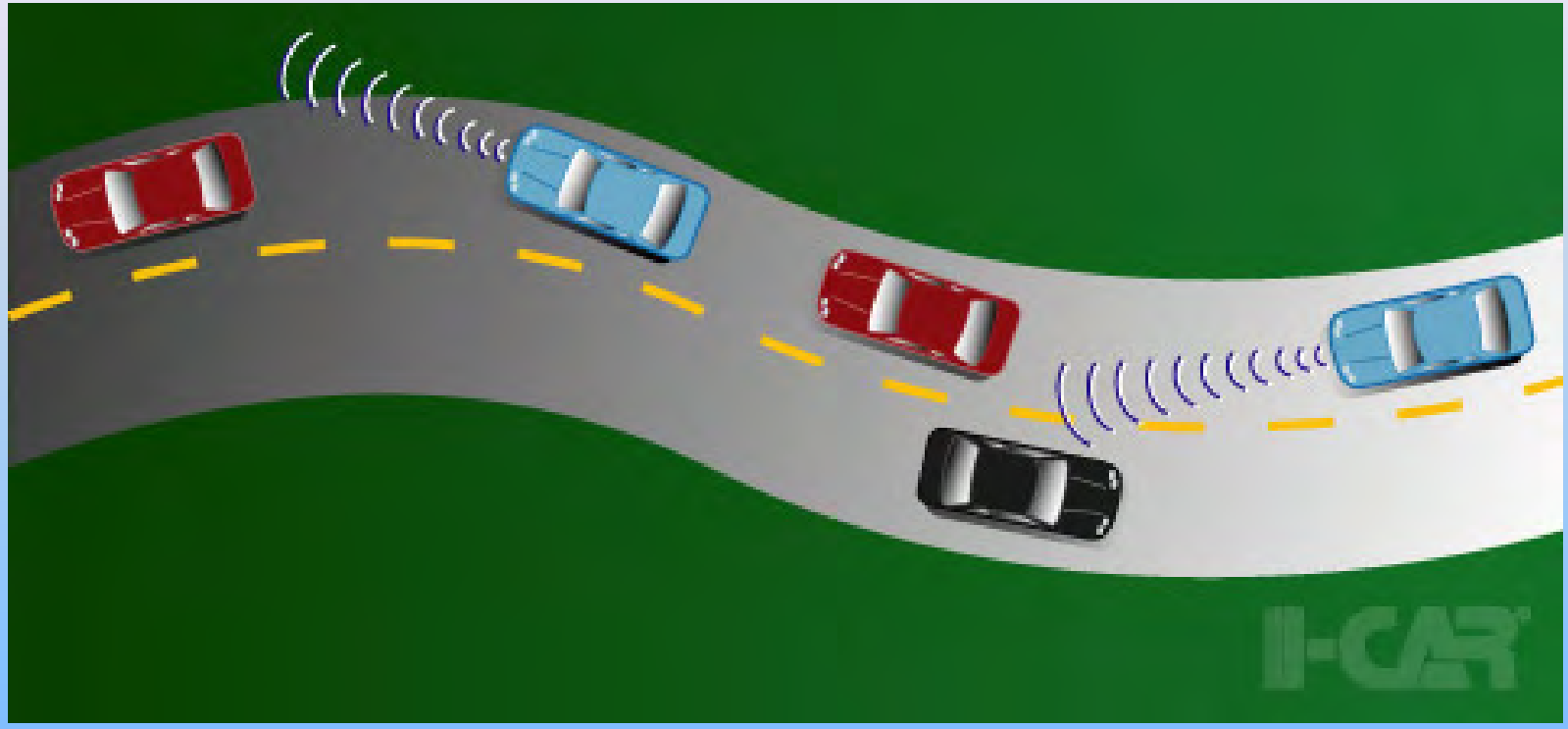


Traveling through a curve might have an effect on ACC operation.

The control module uses information from the radar or laser sensor, vehicle speed sensors, and vehicle steering and yaw rate sensors to monitor following distance and to adjust the vehicle speed accordingly. On a 2006 Cadillac DTS, the engine control module (ECM) provides the speed control to the ACC system.

Adaptive Cruise Control

System Operation



Traveling through a curve might have an effect on ACC operation.

If the forward vehicle slows down or a different vehicle moves in front of the ACC vehicle from another lane, the ACC system automatically reduces engine speed, and may also apply the brakes, to maintain the set following distance.

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System Operation

Vehicle Example

On a 2003 BMW, a curve speed controller evaluates inputs so that speed is limited on curves. When the steering wheel is turned, rapid acceleration of the ACC vehicle is prevented when detection of the forward vehicle is lost in a curve.

Distance Settings

ACC systems provide various vehicle-to-vehicle distance options, which allow a setting appropriate to traffic conditions, such as:

short distance.
medium distance.
long distance.

The vehicle icon is a distance setting on an Infiniti FX45 equipped with ACC.

Vehicle Example

2004 Audi A8 users can choose between four desired distance stages: Distance 1 (Sporty), Distance 2 and Distance 3 (Standard), and Distance 4 (Comfort).
Mercedes-Benz ACC systems allow for a time gap range between one and two seconds.

Adaptive Cruise Control

Laser/Radar Comparison

Both laser- and radar-based ACC sensors operate by projecting a beam forward to detect a vehicle ahead. Radar-based units transmit a millimeter-wave radar signal and receive the reflected signal from the vehicle ahead. Laser-based units transmit laser beam pulses that are reflected back by the vehicle ahead. Bad weather may limit the effectiveness of a laser-based distance sensor.

Here is a laser-based distance sensor on a 2004 Toyota Sienna.

Adaptive Cruise Control

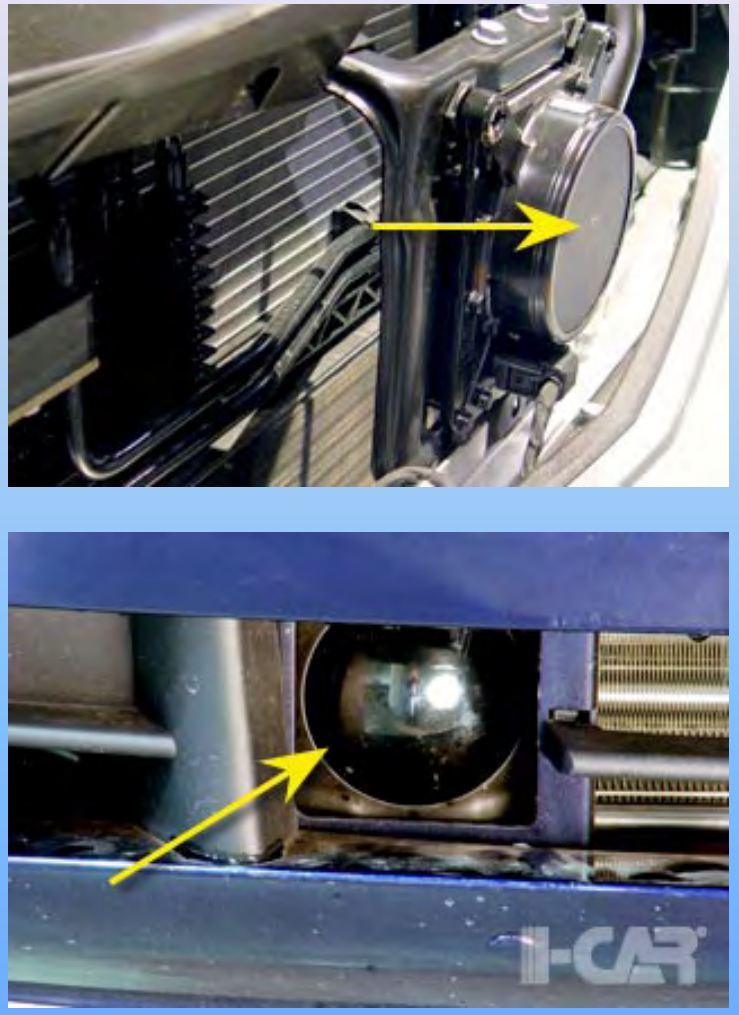
ACC System

The information received by the distance sensor is used to measure the gap between the ACC vehicle and the vehicle ahead, and determine the speed of the forward vehicle.

Advanced ACC Systems

Enhancement to some ACC systems extends the speed range down to a standstill. On some advanced ACC systems the long-range sensor is supplemented with a close-range sensor. This allows for more system involvement when traveling at lower speeds, such as in stop-and-go traffic.

Some of the advanced ACC systems include:
BMW – ACC Stop and Go
Mercedes-Benz – Distronic Plus



Above are radar-based distance sensors on a 2006 Mercedes-Benz (top) and on a 2004 BMW (bottom).

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System Control

Activation/Deactivation

ACC systems may be operated by a control lever on the side of the steering column or with control buttons on the steering wheel. The functionality of the ACC system and the conventional cruise control system is shared.

These steering wheel-mounted cruise control switches are on a 2006 Jaguar XK.

Adaptive Cruise Control

System Control

The system adjustment controls will typically include the following function switches:

- On/off
- Speed
- Distance
- Set
- Resume
- Cancel

These control lever-mounted cruise control switches are on a 2006 Toyota Avalon.

Vehicle Example

On the 2004 Audi A8 the ACC system is operated by a control stalk on the left side of the steering column.

Adaptive Cruise Control

Display Information

Instrument Panel Displays

ACC system status information may be displayed in a message or driver information center (DIC), and/or included in an instrument panel gauge. On the 2004 Audi A8 additional display information may be accessed using a reset button located at the bottom of the wiper stalk.

These are cruise control system status displays on a 2001 Mercedes-Benz (top) and a 2004 Infiniti (bottom).

Adaptive Cruise Control

Display Information

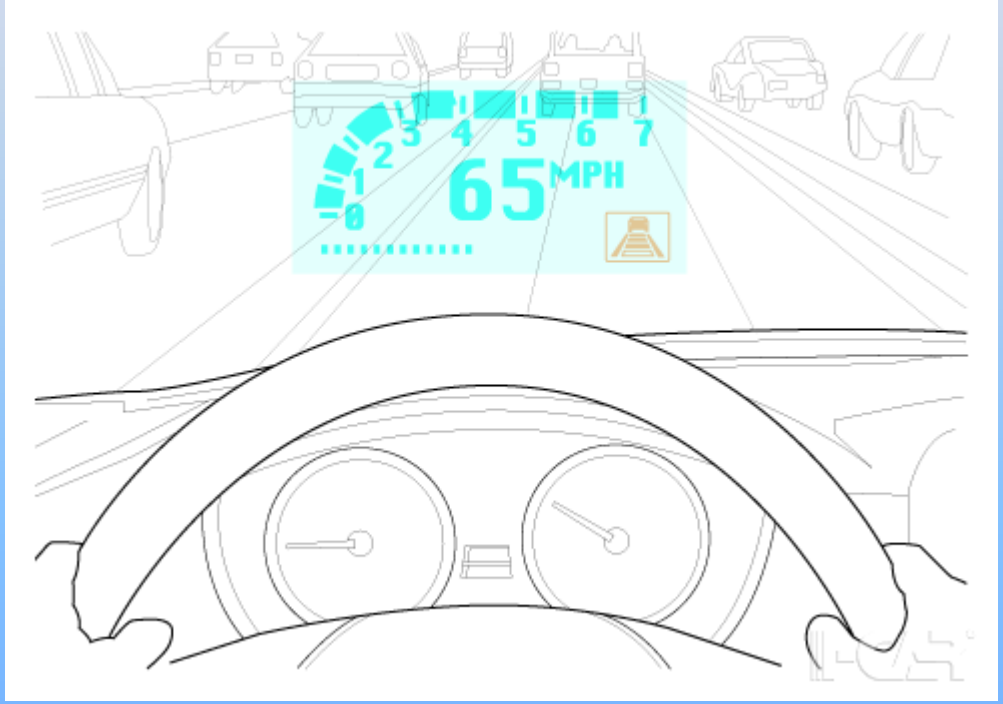
Vehicle Example

On the 2004 Audi A8 the set speed is displayed with an illuminated LED in the speedometer rim.

Other Displays

The 2004–06 Cadillac XLR is equipped with a head-up display (HUD) to show ACC system status information. The driver may have to adjust the position and/or the intensity of the HUD to see the information being displayed. The ACC system will not operate if the HUD fails. The HUD on the 2004–06 Cadillac XLR shows the following ACC status indicators:

- Cruise Speed Limited Message
- Cruise Engaged Telltale
- Vehicle Ahead Telltale
- Tight Curve Message
- Follow Distance Display
- Set Speed Display
- Driver Alert Telltale
- Vehicle Speed Display



The HUD system displays desired information on the windshield, allowing the driver access without having to take their eyes from the road.

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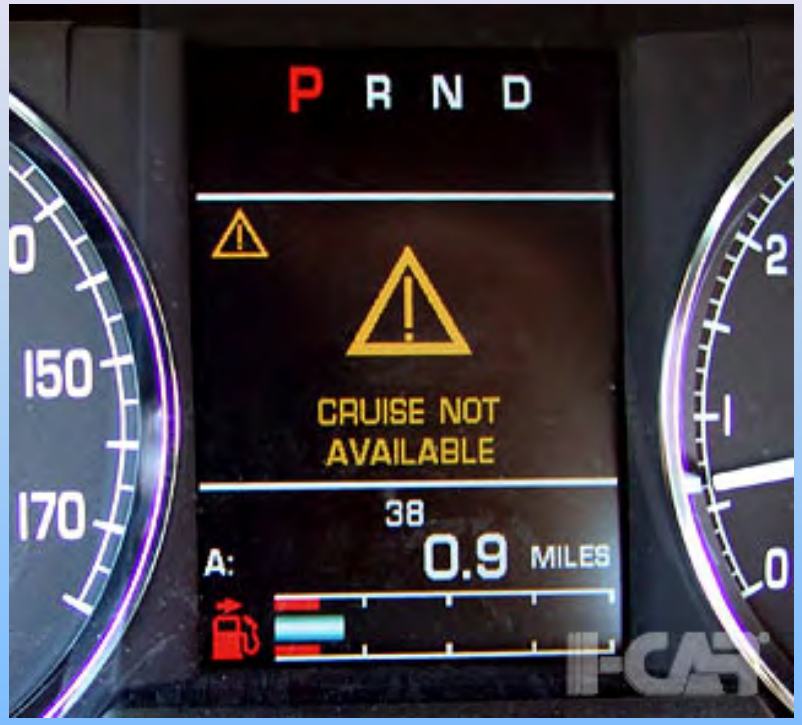
System Malfunctions

System Inhibited

Certain conditions may prevent the ACC from engaging. These conditions include but may not be limited to:

- Sensor obstruction from paint, stickers, a vehicle front protector, excessive mud, snow, etc.
- Vehicle speed too high or too low.
- Heavy cargo causing the front of the ACC vehicle to rise.
- Rear of forward vehicle extremely dirty, or has no reflectors.



An obstructed sensor will prevent the ACC system from engaging.

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System Malfunctions

To ensure that the ACC system functions properly, the distance sensor should be kept clean. Wipe with a soft cloth, being careful to avoid damage to the sensor.

Carefully clean a dirty sensor with a soft cloth.

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System Malfunctions

Vehicle Example

On some BMW models the lens of the ACC sensor may be heated to aid operation in winter and adverse conditions. The heating coil is integrated into the plastic lens body.

On the 2004 Audi A8 the distance control sender cover is made of radar-permeable material and can be heated to prevent possible malfunctioning because of snow and ice.

Disable Conditions

Certain conditions may disable an ACC system. These conditions include but may not be limited to:

- An activated ABS.
- Detected instability, activating the traction/stability control system.
- A brakes overheated signal from the ABS control module (Audi, GM).

The ACC system may be disabled when the ABS is activated.

Adaptive Cruise Control

System Fault

Sensor Alignment

Correct alignment of an ACC distance sensor is critical for proper system operation. Horizontal misalignment may result in the erroneous detection of a vehicle in an adjacent lane.

Situations that result in an out-of-alignment condition may include tampering, damage to the distance sensor and/or mounting brackets, or normal wear deterioration.

Alignment of a distance sensor outside the recommended parameters may set a diagnostic trouble code (DTC).

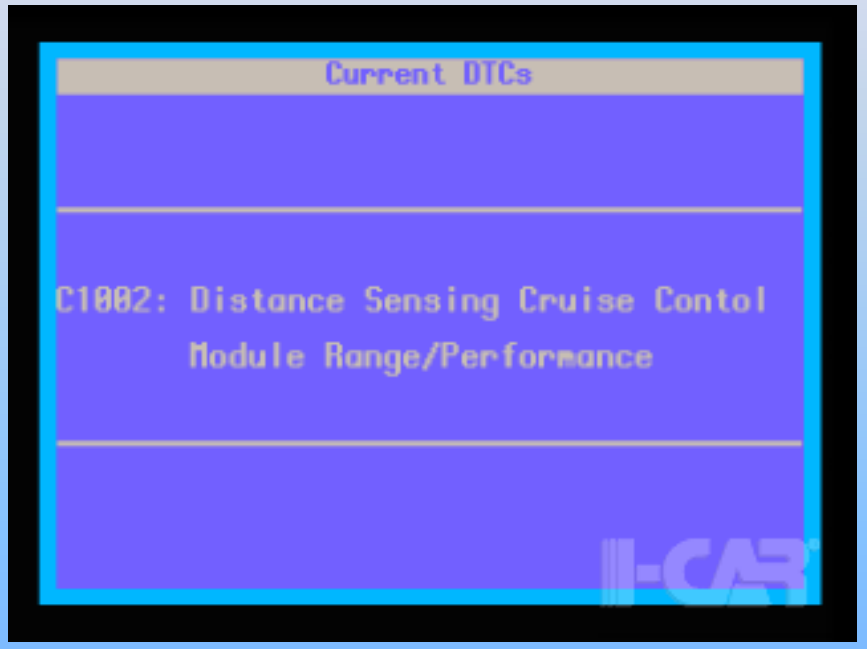
A damaged mounting structure may result in an out-of-alignment sensor.

Adaptive Cruise Control

System Fault

Vehicle Example
When the distance sensing cruise control (DSCC) module on a 2006 Cadillac DTS detects that the forward looking sensor (FLS) radar is out of alignment, a DTC C1002 sets. Conditions for setting this DTC include:

- A 3.9 degree of skew or error of the FLS
- The vehicle speed at or greater than 40.2km/h (25 mph)



This is a scan tool display of an out-of-alignment DTC (C1002) on a 2006 Cadillac DTS.

Vehicle Example
For the 2004 Audi A8, the distance control sender must be mechanically set after: replacement of the sender, sender holder, bumper cross member, or front end. damage (such as after a collision).

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Check And Clear DTC's

To check for a DTC on a 2006 Lexus RX330 use the following steps:

1. Connect the appropriate scan tool to the data link connector (DLC).
2. Turn the ignition switch to the ON position.
3. Read the DTCs by following the prompts on the scan tool display screen.

To clear a DTC on a 2006 Lexus RX330 use the following steps:

1. Connect the appropriate scan tool to the DLC.
2. Turn the ignition switch to the ON position.
3. Clear the DTCs following the prompts on the scan tool display screen.

A scan tool may be necessary to read and clear ACC-related DTCs.

Adaptive Cruise Control

Adjusting Sensors

Work Area

A cruise control distance sensor aiming procedure requires a level and unobstructed space. Refer to the appropriate procedure to determine area requirements.

The size of the area required for a distance sensor aiming procedure may vary depending on the vehicle maker.

Adaptive Cruise Control

Adjusting Sensors

Vehicle Example

The area required in front of the vehicle for a 2006 Lexus RX330 laser sensor assembly adjustment is 9 m (29.53') deep by 3 m (9.84') wide.

The 2004 Audi A8 distance setting is performed on wheel alignment equipment.

Reference lines are used to mark the floor and wall to position the vehicle for the aiming procedure. To ensure proper sensor alignment, the vehicle must be aligned correctly to the reference lines. Refer to the appropriate procedure for the necessary measurements.

The layout area needed for aiming a 2006 Cadillac DTS distance sensor consists of a vertical wall 1.5 m (5') high by 3.6 m (12') wide, and a level floor, 12.8 m (42') long by 3.6 m (12') wide. The area for this layout should be unobstructed, and the wall should have a washable, non-gloss, white finish.

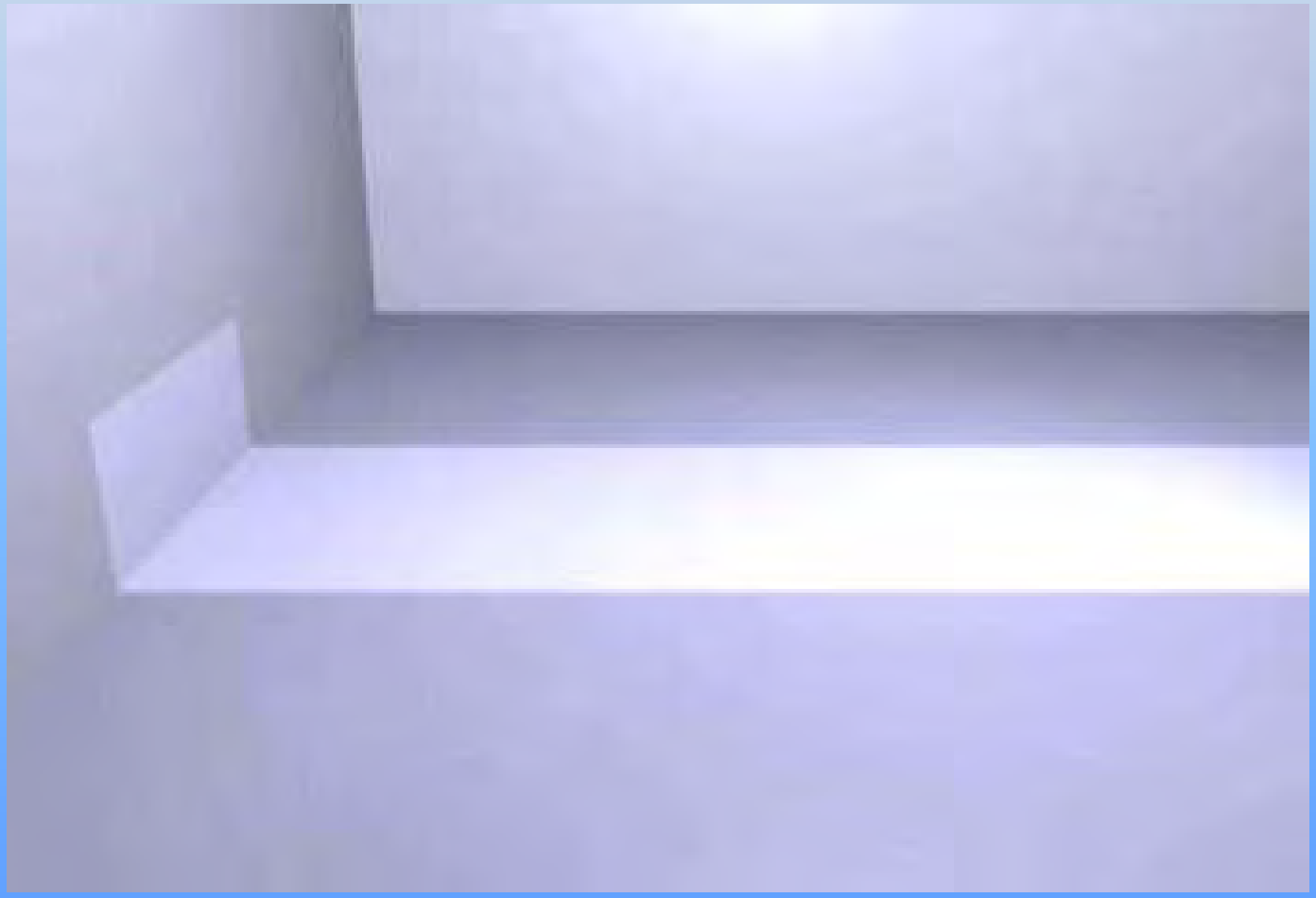
Three reference lines need to be made to determine the vehicle positioning. Paint or tape may be used for reference lines. Use a plumb line to ensure a straight vertical line. A chalk line tool may be used for making temporary lines.

Adaptive Cruise Control

Adjusting Sensors

This movie shows how to make the vehicle position layout for doing a cruise control distance sensor aiming procedure on a 2006 Cadillac DTS.

See Video Script on next slide (Click movie frame to play)



Adaptive Cruise Control

Adjusting Sensors

Video Script

For reference line A, make a 51 mm (2") vertical line on the wall, 1 m (3') up from the floor, and 610 mm (2') from the left edge of the layout area.

Use the following measurements for locating reference line B:

1. Mark point #1 on the floor at the bottom of reference line A.
2. Measure 1.8 m (6') from point #1 to the right of reference line A and mark point #2 on the floor at the base of the wall.
3. Mark temporary line #3, 2.4 m (8') straight back from point #1 at the bottom of reference line A.
4. Mark temporary line #4, 3 m (10') from point #2, to line #3, and mark point #5 where the lines intersect.
5. For reference line B, make a 51 mm (2") line on the floor, 11.6 m (38') long, at a 90º right angle from reference line A, going through point #5.

For reference line C, make a 51 mm (2") line on the floor 305 mm (1') long, parallel to the wall, left of reference line B, and 8.4 m (27' 5.2") from the wall.

On the wall make a target for the alignment tool laser beam. Measure 660 mm (2' 2") up from the floor and 908 mm (2' 9.25") from the outer edge of reference line A. Make a 51 mm (2") circle with the center where the measurements intersect.

To align the vehicle, position the outer edge of the left side tires to the outer edge of reference line B. Align the center of the left front tire directly over reference line C.

Adaptive Cruise Control

Adjusting Sensors

Aiming Procedure

Before doing the aiming procedure, the following may be necessary:

•Align the wheels. If the thrust angle is not correct, the front of the vehicle may not be pointing straight ahead.

•Inflate the tires to the proper pressure.

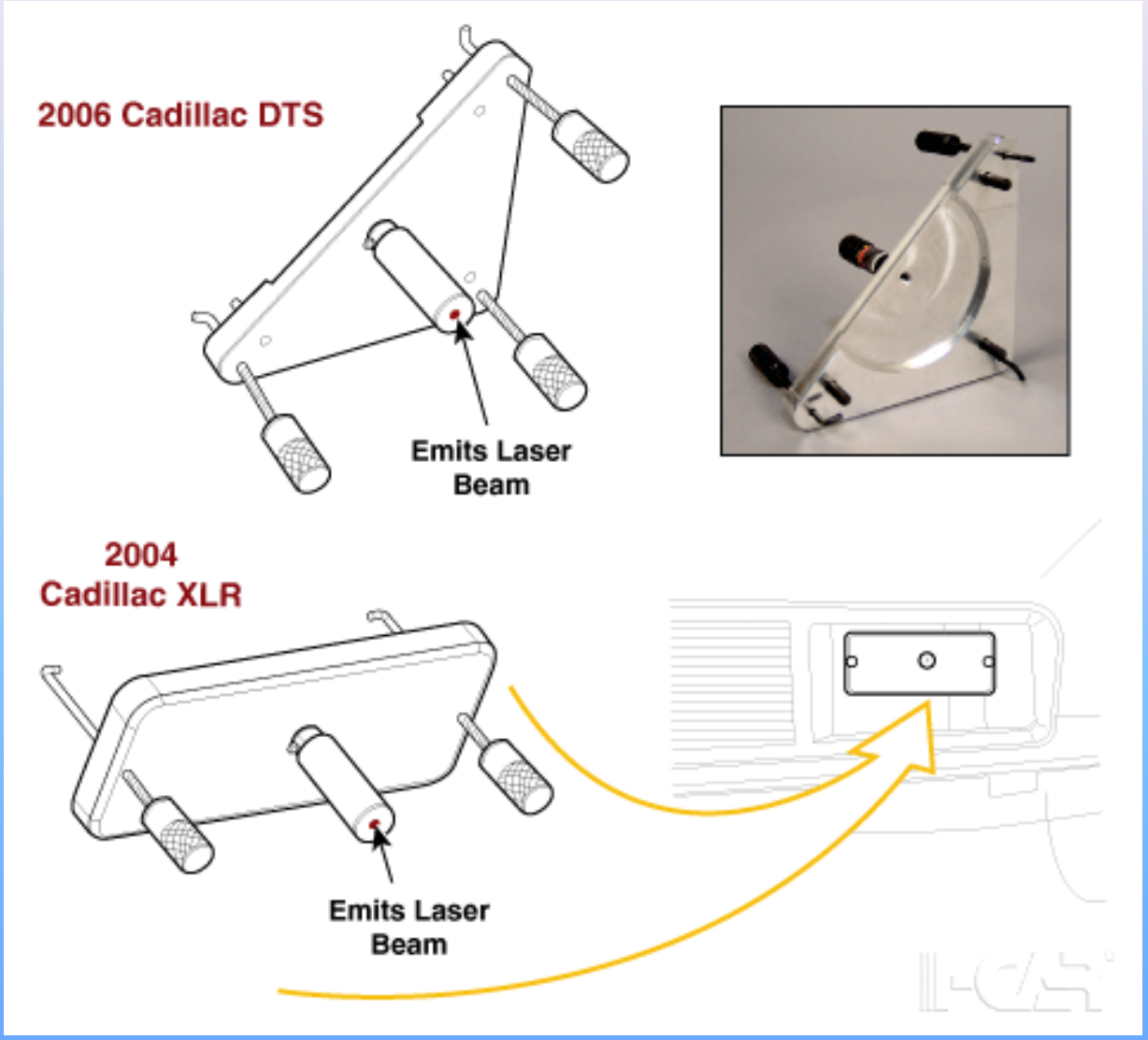
•Ensure the vehicle fuel tank is full.

•Remove luggage, cargo, snow, ice, or mud from the vehicle.

•Ensure all vehicle parts are in their original place.

Proper tire inflation and removing cargo from the trunk may be necessary to correctly align a sensor.

Adaptive Cruise Control



Using a special aiming tool is necessary to align a sensor, such as the tools shown for a 2006 Cadillac DTS and the 2004 Cadillac XLR.

Adaptive Cruise Control

Adjusting Sensors

A special vehicle-specific aiming tool may be required to do the aiming procedure.
To complete the aiming procedure on the 2006 Cadillac DTS:

1. Open the hood.
2. Remove the front compartment sight shields.
3. Remove the grille from the fascia.
4. Install the ACC radar alignment tool to the front of the DSCC module.
5. Check that the spring tension rods are installed in the proper position.
6. Turn the laser beam on.
7. Adjust the horizontal aim screw and vertical aim screw of the DSCC module until the laser beam is in the center of the target on the vertical wall.
8. Turn off the laser beam.
9. Install a scan tool.
10. Turn ON the ignition, with the engine off.
11. With the scan tool, perform the Factory Reset for the DSCC module in the Body and Accessories, Cruise Control Special Functions.
12. Remove the ACC radar alignment tool from the DSCC module.
13. Install the grille to the fascia.
14. Install the front compartment sight shields.
15. Close the hood.

Adaptive Cruise Control

Repairs

Beginning Repairs

Before beginning repairs, access the appropriate service information for specific vehicle maker requirements.

Items to be aware of include:

vehicle-specific replacement or repair procedures.

other possibly affected parts or systems.

Access appropriate service information.

Adaptive Cruise Control

Repairs

Take all necessary precautions to ensure personal safety and to avoid damage to sensitive electronic parts. If necessary:

- Disconnect and isolate the battery cables.
  - Negative cable first
  - May need battery power for diagnostics
- Disable the affected restraint system zones.

Make sure all related panels and parts have been removed from the repair area.

Disconnect and isolate the battery cables, disconnecting the negative cable first.

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Removal

To remove a DSCC module on a 2006 Cadillac DTS:

1. Loosen the bolts that hold the cruise control module into the T-slots on the tie bar.
2. Disconnect the electrical connector.
3. Slide the module out of the T-slots on the bracket.

Installation

When installing replacement parts, be sure to follow vehicle maker requirements. To install a DSCC module on a 2006 Cadillac DTS:

1. Slide the assembly into the T-slots on the bracket and tighten (9 N•m (80 lb in)). Refer to the mandatory tightening sequence.
2. Verify proper alignment of the module. Refer to the DSCC aiming procedure.

An ACC distance sensor is being removed from a 2006 Jaguar XK.

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Inspect Repairs

Verify Proper Operation

Once the repair process is finished, inspect the parts and test for proper operation. Inspecting repairs may include:

•Connecting a scan tool to the DLC to verify specific parts are operational.

•Test-driving the vehicle to verify the ACC system is functioning properly.

A test drive will verify that repairs have been done properly.

This instrument panel display shows the ACC in operation.

Thank You

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